Erratum: “Exact nonlinear analytic Vlasov-Maxwell tangential equilibria with arbitrary density and temperature profiles” [Phys. Plasmas 10, 2501 (2003)]

F. Mottez

Corrections to "Exact nonlinear analytic Vlasov-Maxwell tangential equilibria with arbitrary density and temperature profiles" by F. Mottez

V. Génot and F. Mottez

Corrections

In Eq. (5), π has to be replaced by π^3.

Note that in Eqs. (5) and (11) n_0 has to be understood as a density per unit of potential vector.

In Eq. (18), $-q$ has to be replaced by q.

In order to detail the way particle distributions are chosen the paragraph starting below Eq. (27) with "It is easy to show ..." and finishing with Eq. (29) is replaced by :

"The system of Eqs. (25)-(27) involves eight free parameters (or functions if they depend on a). Therefore we are left with the choice of five parameters whereas the three remaining ones are determined by the system. There is only one restriction: η must be positive. Different strategies may be adopted for this choice. For instance, assuming a similar profile $n_g(a)$ for ions and electrons, we can freely choose the functions $\alpha_\perp$, η and ν for one species and deduce the functions associated to the other species. The positivity of η implies to set ion and electron temperatures ($\alpha_{\perp i}$ and $\alpha_{\perp e}$), and then to choose η_e which must satisfy

$$\frac{m_e}{\eta_e(a)} > 2\left[\left(\frac{m_i}{m_e}\right)T_{\perp i}(a) - T_{\perp e}(a)\right] \tag{28}$$

(Note the corrected form). This requires small enough values of $\eta_e(a)$. Noticing that η is homogeneous to the reciprocal of a squared velocity, $v_\eta^2 = 1/\eta_e$, the above relation is equivalent to

$$v_\eta^2 > \left(\frac{m_i}{m_e}\frac{T_{\perp i}}{T_{\perp e}} - 1\right) v_{te}^2 \tag{29}$$

(Note the corrected form). This is also coherent with the knowledge of the plasma we want to model: temperatures are physical quantities deduced from observations or set a priori, whereas η and ν are ad-hoc parameters. This strategy also gives control on the shape of distribution functions (as $n_g(a)$ for ions and electrons are set). It is then possible to analytically solve Eqs. (25)-(27) for the remaining parameters: η_i, ν_i and ν_e.

Another strategy in the choice of parameters is to set $T_{\perp e}$, $T_{\perp i}$, η_e according to Eq. (28), and ν_e and n_{ge}, which entirely determines the electron distribution function. The remaining parameters η_i, ν_i and n_{gi} are then easily obtained from Eqs. (25)-(27). If $\eta_e = 0$ ($\nu_e = 0$) then $\eta_i = 0$ ($\nu_i = 0$) and we are left with six parameters and two equations."

Below Eq. (35) we detail the definition of C : "C is an integration constant which is equal to the square of the magnetic field amplitude far from the discontinuity."

Eqs. (36) and (37) must be replaced respectively by

$$B_z(x)^2 = C + \int_{y_1}^{y_2} dy B_z(y) k(A_y(y)) e^{-\xi(A_y(y))\left[\int_y^x B_z(u)du\right]^2 + \delta(A_y(y))\left[\int_y^x B_z(u)du\right]} \tag{36}$$

and

$$n(x) = n_0 + \int_{y_1}^{y_2} dy B_z(y) N_0(A_y(y)) e^{-\xi(A_y(y))\left[\int_y^x B_z(u)du\right]^2 + \delta(A_y(y))\left[\int_y^x B_z(u)du\right]} \tag{37}$$

The fourth paragraph in section III.B now starts with : "We consider the case $a_1 = -\infty$ and $a_2 = +\infty$. Let $u^- = \lim_{x\to-\infty} u$ be the limit of any field $u(x)$ (like B_z and n) when x tends to $-\infty$, and $u^- = \lim_{x\to-\infty} u(a(x))$ the limit of any function $u(a)$ (like ξ, η, and δ). Let us set similar notations when $x \to +\infty$. The integral in Eq. (36) ..."

Wrong versions of the figures were provided. The following changes apply:

- Figures 1, 2, and 3: the unit of J_y is μA/m^2 instead of micro Ampere/m.
- Figure 4: the unit of J_y is μA/m^2 instead of nA/m^2.
- On Figure 5 (a new figure is provided) quantities are presented as functions of Earth radii which is more relevant to current sheet equilibrium (similar to the Harris one for the magnetotail). Note the corrected values of the current. Also we chose $\nu = 10^{-9}$ to comply with magnetotail typical size.
- On Figure 6 (a new figure is provided), the density is no longer negative (n_{g0} is set to 40000). Note that the ion temperature is constant (1 eV).

References

Mottez, F., Exact nonlinear analytic Vlasov-Maxwell tangential equilibria with arbitrary density and temperature profiles, *Phys. Plasma, 10* (6): 2501-2508 June 2003.

Figures

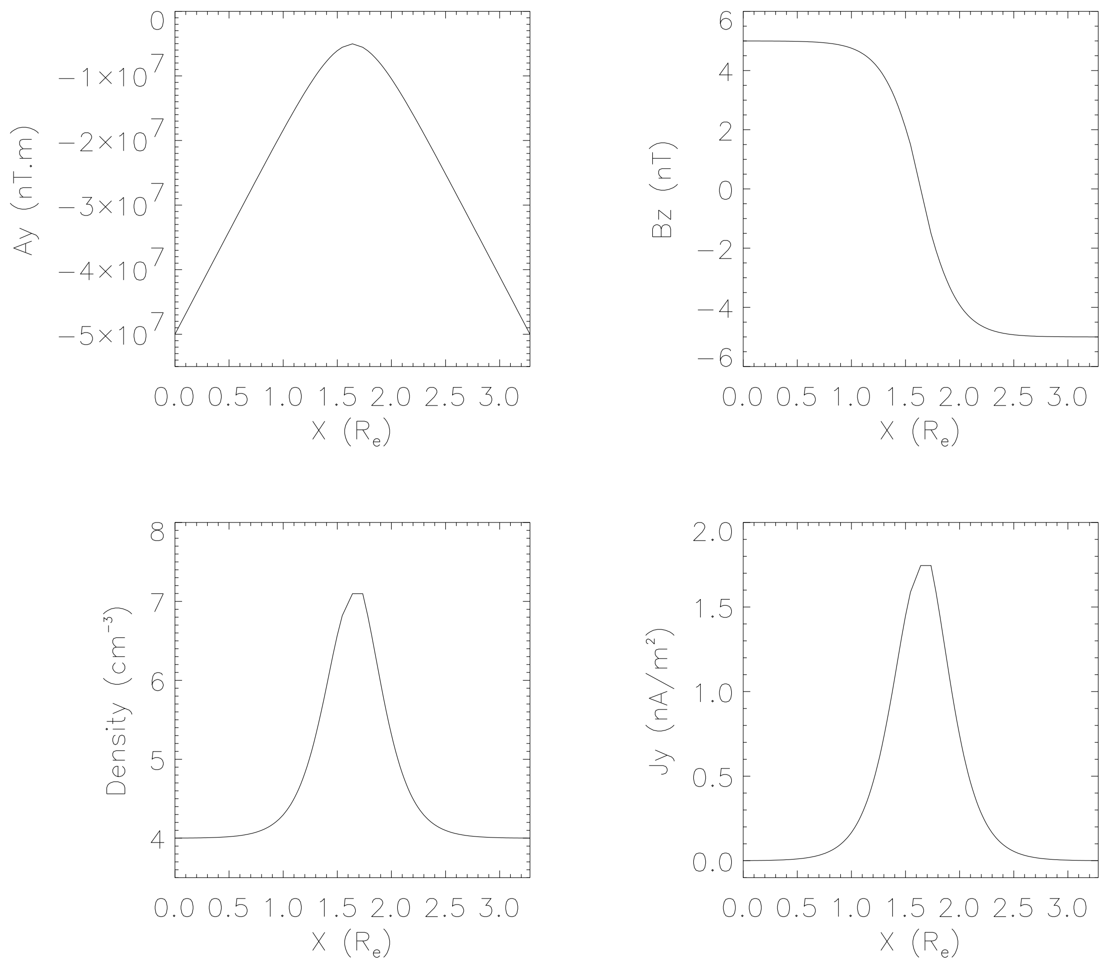

Figure 5. An example of an equilibrium with $\eta = 0$ and a reversal of the magnetic field. Details are given in Sec III.C.

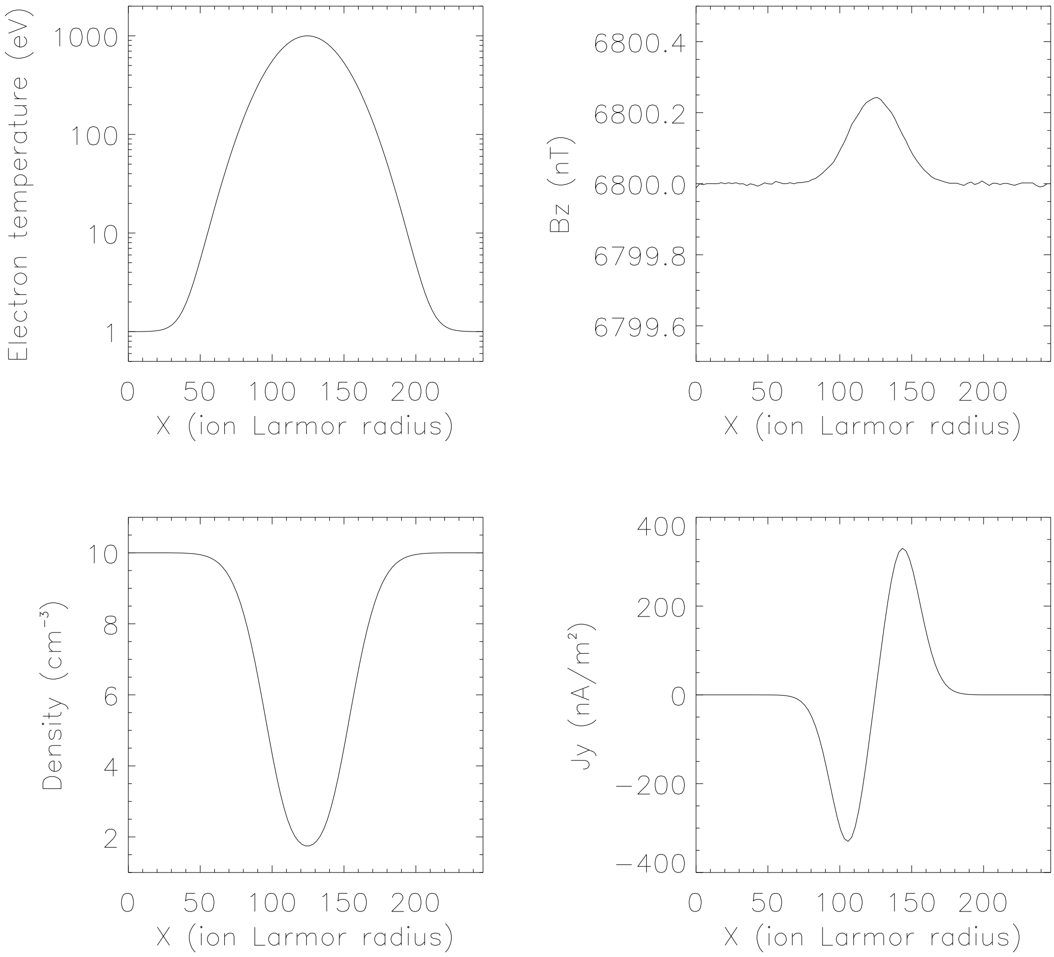

Figure 6. An example of a deep plasma cavity containing hot electrons (1 keV) surrounded by a cold (1 eV) highly magnetized plasma. See section III.D for details.